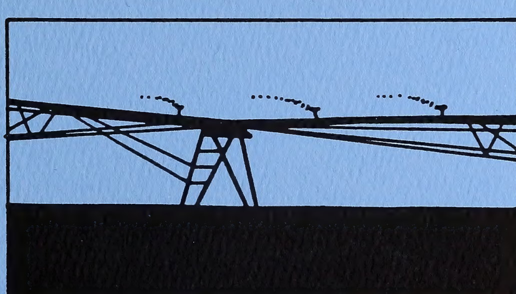
IRRIGATION AND RESOURCE MANAGEMENT DIVISION



Applied Research Report 1996 – 1997

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RURAL DEVELOPMENT

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Applied Research Report

Irrigation and Resource Management Division

Alberta Agriculture, Food and Rural Development

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Preface

The Irrigation and Resource Management Division Annual Applied Research Report is a collection of progress and final summary reports. The research is carried out by staff members of the Division and private consultants retained under contract. Research projects vary from detailed tests to field surveys and from irrigation to conservation topics.

The reports are limited in length and summarize the highlights. Detailed data and information are available from the individual researchers. The authors are responsible for the contents of their articles.

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Acknowledgements

I would like to thank the staff members who carried out the research and prepared the reports in this 1996-97 edition of the Applied Research Report of the Irrigation and Resource Management Division. I acknowledge the great effort to plan and carry out these projects. I also appreciate the encouragement and support provided by their supervisors. On behalf of all, I thank the farmers, irrigation districts, agricultural research associations, agricultural organizations and agricultural service boards for their cooperation.

Special thanks to Carly King, Susan Randolph and Hank Vanderpluym for compiling, proofing and formatting the report.

Brian L. Colgan, Director
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Contents

Agricultural Impacts on Surface Water Quality in the Crowfoot Creek Watershed

Objective(s): To determine if agricultural practices are affecting water quality in the Crowfoot Creek watershed, and, if so, identify land uses having an effect and recommend remedial measures.

Background: The main contaminants in the Bow River within the reach where the Crowfoot Creek discharges were described by the Bow River Water Quality Task Force in 1991 as nutrients, bacteria and trace elements. A preliminary review of available data, conducted by Madawaska Consulting in 1995, confirmed high concentrations of fecal coliform bacteria and total phosphorus in Crowfoot Creek.

Water quality concerns in Crowfoot Creek resulted in the formation of a study team consisting of Wheatland County, the Western and Eastern Irrigation Districts, Ducks Unlimited Canada, the Village of Standard, local producers, the Irrigation Branch (Alberta Agriculture, Food and Rural Development), and the Water Sciences Branch (Alberta Environmental Protection). About 70 people attended a public meeting in Standard last April wherein the project was introduced.

Division Key Results: This project contributes to sustained or enhanced water quality by identifying agricultural practices which may affect water quality, and recommending remedial measures (if required) to reduce impacts.

Project Description: The Crowfoot Creek watershed is located east of the town of Strathmore in Wheatland County, and comprises an area of mixed irrigated and dryland agricultural production of about 1600 km^2. Natural flows in the creek originate as runoff from snowmelt or high rainfall. Flow in the creek is augmented from May to October by deliveries or spills of irrigation water from the Western Irrigation District. Water in the creek and downstream in the Bow River is used for irrigation, livestock watering, domestic use, wildlife habitat through constructed wetlands, and recreation.

A network of 28 sites was established in 1996 to measure flow and to assess water quality. Sites were selected on the basis of a preliminary assessment of land use, and through consultations with local producers, Wheatland County, Ducks Unlimited, the Western Irrigation District and the Village of Standard. Flow is being determined at 25 sites, of which 19 are automated using stilling wells and dataloggers. The other flow monitoring sites use staff gauges for flow measurement. Flow is estimated at all sites by manually metering flow and developing stage-discharge curves that relate discharge to depth of water in the channel. Water sampling will be conducted at all sites daily during spring runoff and weekly from early May to late October. Automatic (ISCO) water samplers, which collect composite samples over a 24-hour period, are used at 11 sites

where flow is continuous or quality is expected to vary significantly. These samplers are programmed to respond to changes in flow, such as following a high rainfall event with runoff, and take a composite sample during the event. Grab samples are taken at the remaining sites for weekly and event sampling. Water samples are analysed for nutrients (nitrogen and phosphorus), salinity and bacteria (fecal coliforms and *E. coli*). Additional analyses will include testing for nine soluble trace elements three times per year, and testing for 31 different pesticides at selected locations for eight consecutive weeks in 1997. Water samples collected daily (five days per week) by the Eastern Irrigation District at the watershed outlet are also being analysed for fecal coliforms and *E coli.*

Agricultural practices that may contribute to impaired water quality will be identified in conjunction with detailed land use, flow measurement and water quality monitoring. Best management practices that could mitigate water quality problems will be identified and extended to local producers.

Project Results: Preliminary results from limited sampling during 1996 are presented. Fecal coliforms and *E. coli* exceeded guidelines for irrigation (100/100 ml) and recreation (200/100 ml) at most locations and times, and always exceeded guidelines for drinking water (0/100 ml). Some of the lowest fecal coliform and *E. coli* levels occurred downstream of a Ducks Unlimited wetland project. Total phosphorus concentrations exceeded the Alberta Ambient Surface Water Quality Interim Guideline of 0.5 mg/L at most locations and times. A one-day rain of about 30 mm in mid-September caused concentrations of most constituents to increase two to five times relative to concentrations during non-rain periods.

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Supporting Agencies: Wheatland County, Western Irrigation District, Eastern Irrigation District, Ducks Unlimited Canada, Farming for the Future Matching Grants Program

Best Management Practices for Preventing Water Erosion on Farmland

Objective(s): To evaluate the impacts of conservation tillage, crop rotations, crop residue management, and the use of tillage implements on soil loss on farm land in Alberta.

Background: Research is underway in Alberta to develop best management practices (BMP) for controlling water erosion on agricultural land. The U.S. Department of Agriculture computer model, called the Water Erosion Prediction Project (WEPP), is being used in this research.

Division Key Results: Adaptation and application of the model will help to develop best management practices that reduce water erosion in Alberta.

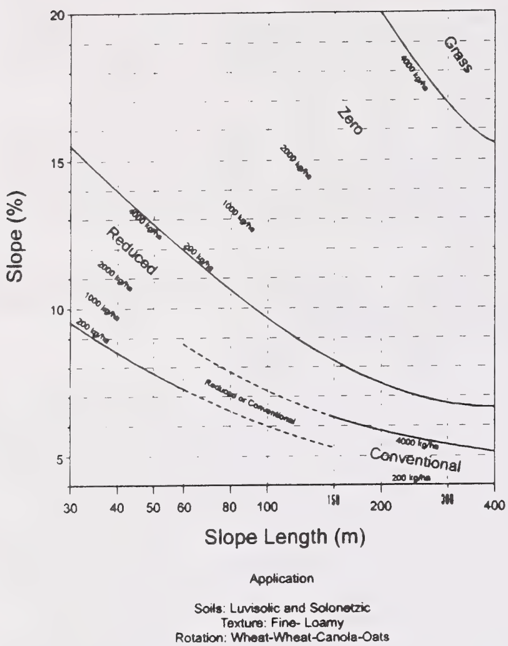
Project Description: To evaluate farming practices, common cultivated soils were selected on various landscapes from the Luvisolic, Solonetzic, and Chernozemic Soil Orders. Fine-loamy and clayey textured soils are the most prevalent textures in Alberta and are used here. Each Soil Order has a different level of *tolerable soil loss* (Tajek et al. 1985), based on the amount of top soil that the soil theoretically regenerates annually. Solonetzic and Luvisolic soils typically have a shallow A horizon (the topsoil layer is thin), and low organic matter content. They have tolerable soil loss limits of 1.5 and 2.5 tonnes per hectare per year (t/ha/yr), respectively. In contrast, Chernozemic soils have a higher organic matter content and better developed soil profiles (the topsoil layer is thicker). As a result they could possibly sustain up to 6 t/ha/yr of soil loss.

Project Results: Three main tillage systems were compared for potential soil loss on a 50 m long and 9% steep slope: conventional, reduced, and zero tillage. Simulations show that changing tillage from a conventional to a reduced, and then a zero tillage management system under a wheat-wheat-canola-fallow (W-W-C-F) rotation would decrease water erosion potential from 8.9, to 5.4 and then to 0.4 t/ha/year.

Analysis shows that over a long time the following four crop rotations under conventional tillage exceed tolerable soil loss (2.5 t/ha/year): 1) wheat - oats (forage) - fallow, 2) wheat - wheat - canola - fallow, 3) wheat - wheat - fallow, 4) wheat - fallow. The use of conventional fallow within the W-W-C-F rotation increases the potential for soil loss by more than 400% compared with wheat - wheat - canola - oats (W-W-C-O) rotation. On conventional fallow, soil particles are quite easily detached by rain drops and concentrated surface flow because the soil is unprotected by plants.

In contrast, the following rotations, result in significantly reduced water erosion: 1) wheat - wheat - alfalfa - alfalfa - alfalfa, 2) wheat - wheat - canola - oats, 3) wheat (continuous), 4) wheat - wheat - canola. The presence of perennial forage following cereal cropping in the first rotation reduces erosion by more than 230% compared with the continuous wheat rotation.

Figure 1



Using Alberta data, WEPP simulations were run for crop residue cover varying from 200 kg/ha to 4000 kg/ha under a wheat-wheat-canola-oats rotation. The results from the WEPP simulations were used to develop a residue management chart assuming a Luvisolic or Solonetzic soil with a fine-loamy texture (Figure 1). This chart helps define minimum residue levels that need to be left on the soil surface after harvest for a specific tillage practice. The first step in using the chart is to define slope steepness and slope length for the specific location. The slope length is the distance from the top of the slope to the location of concentrated water flow or soil deposition at the bottom of the slope. It can be measured by pacing out a flow path directly on the ground. The slope steepness is the ratio of the change in elevation over the horizontal distance. The next step is to enter these values into the chart and read the required minimum residue level for the corresponding tillage practice. In the places where conventional tillage overlaps with reduced tillage, a farmer could choose either tillage practice and maintain either higher or lower residue levels accordingly.

Conclusions: The main benefit of using the WEPP model in this research is its ability to predict adequate crop residue cover for specific soil, landscape and farm management conditions. It is clear from the example chart in Figure 1 that the minimum residue cover requirement is not a fixed number, and needs to be defined for a specific field condition.

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Supporting Agencies: Canada-Alberta Environmentally Sustainable Agriculture Agreement, University of Alberta, Agriculture and Agri-Food Canada, Alberta Agriculture, Food and Rural Development

Changes in Soil Infiltration Rate Caused by Alternating Applications of Rain and Saline-Sodic Irrigation Water

Objective(s): To determine changes in infiltration rate on a soil irrigated with saline-sodic water alternating with simulated rain.

Background: Use of saline-sodic water for irrigation increased on the prairies during the 1980s because of increased demand for scarce water supplies. Comprehensive irrigation water quality guidelines have been developed for arid regions which continuously use saline-sodic waters for irrigation. In prairie environments, however, rain supplies about half the water requirement of irrigated crops. There is limited evidence that continued use of a saline-sodic water is less damaging to soil structure and water infiltration than is alternating saline-sodic water with good quality rain. The introduction of fresh rain to a soil initially equilibrated with a saline-sodic water causes a rapid reduction in the salt concentration, which may cause slaking of soil aggregates, swelling and dispersion of soil, with a corresponding reduction in infiltration rate.

Division Key Results: This project contributes to sustained soil quality by developing guidelines for the use of saline-sodic irrigation water in rainfed areas.

Project Description: Semi-disturbed soil cores were equilibrated with irrigation waters ranging in quality from conventional irrigation water (W1) to moderately saline and sodic (W7). One crop year was then simulated by applying eleven cycles of 40 mm of water, alternating between irrigation and rain water. Water was applied by sprinkling on the soil surface using "drop formers" (simulated rain) at a rate of 40 mm/h for 1 h. Mechanical energy of the water was about 10 J/mm/m^2. Drying cycles, about 15 h in duration, were done with a fan between successive applications. This partially simulated drying cycles in the field. Total water applied (440 mm) was roughly equal to the consumptive use of a soft wheat crop.

During water application and recession, the height of water ponded on the soil surface was measured. Plots of cumulative infiltration vs cumulative time were prepared and curves of the form $CI = at^b$ were fit to the data, where CI is cumulative infiltration, t is cumulative time, and a and b are empirical coefficients. The derivative (dCI/dt) yields the infiltration rate (IR) at any point in time.

Project Results: Preliminary results from four of the seven irrigation waters are shown in Figure 1. The largest reductions in IR occurred in the first irrigation with simulated rain. Subsequent irrigations with simulated rain caused lesser reductions in IR relative to the first irrigation. Application of irrigation water resulted in recovery of IR. Recovery was generally greater with an increasing number of irrigations and with waters of higher salinity and sodicity. After the final irrigation the relative IRs were 25, 29, 74, and 137% of the original IRs for W1, W2, W4 and W7, respectively.

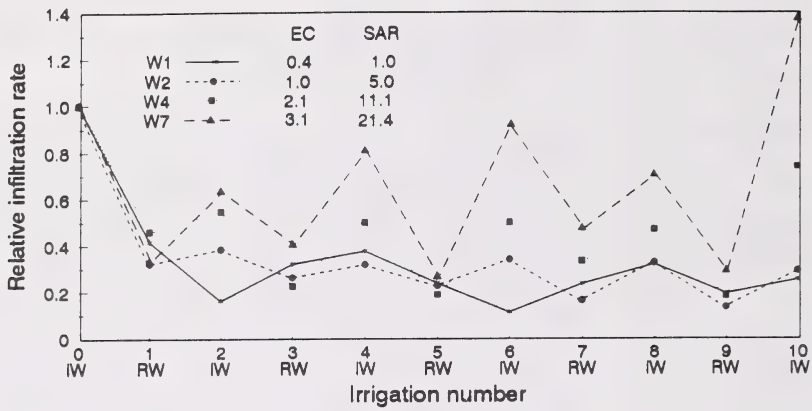

Figure 1. Relative infiltration rates from alternating rain tests. Irrigation zero represents the base to which subsequent irrigations are compared. IW is irrigation water, RW is rain water, EC is electrical conductivity in decisiemens/m, SAR is sodium adsorption ratio.

Conclusions: Previous studies have shown little or no recovery in IR upon reapplication of irrigation water following rain, which is in contrast to our results. Other studies used repacked soil and did not provide a drying cycle between simulated irrigations. In our work, the drying cycle caused soil shrinkage and cracking of the surface soil. The higher the salinity and sodicity of the water, and the greater the number of drying cycles, the greater the cracking. The cracks imparted a high IR that was maintained by the high salinity of the irrigation water. When rain was applied, the electrolyte at the soil surface and in the cracks was leached, resulting in a decline in IR. Cracking was limited with irrigation waters of lower salinity and sodicity (W1, W2), which explains why the increase in IR with irrigation waters was less than that with waters of higher salinity and sodicity (W4, W7).

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Supporting Agencies: University of Saskatchewan, Agriculture and Agri-Food Canada

Crop Consumptive Use Patterns in the North Rolling Hills Drain Watershed

Objective(s): To determine the crop consumptive use and various hydrologic aspects of properly managed irrigated fields within a defined watershed to assist the Eastern Irrigation District (EID) in its part of the ongoing work on the Irrigation Requirements Model.

Background: The irrigation districts in southern Alberta have been put under increasing pressure from environmental and urban interests to increase the water use efficiencies within the limits of their existing water diversion licences. The EID began a process to "audit" its overall use and management of water beginning with the 1994 diversion period. While dealing with annual water balances for the entire region of the EID, a more detailed monitoring project in the Rolling Hills area of the district has completed its third year of operation. In 1995, the Irrigation Branch - Brooks district office of Alberta Agriculture, Food and Rural Development entered into the ongoing research project, assisting the EID in determining some of the on-farm aspects of the "water audit". This portion of the project examines how water is used once it is delivered to farms, how much water is consumed by crops, what losses there may be and where they occur. This added component is intended to provide opportunities to determine where water savings, either from an irrigation network management or on-farm irrigator perspective, might be achieved.

Division Key Results: This project will contribute to helping improve irrigation water management and conservation.

Project Description: A summer student recorded field measurements on 12 farms within the watershed, including rainfall, applied moisture, runoff, water tables, deep percolation, crop growth stages (BBCH) and moisture use. A weather station, provided by the EID, was erected in the spring near the centre of the watershed. Potential evapotranspiration was calculated using the modified Jensen-Haise estimation model. The crop consumptive use was calculated weekly for each field to help schedule irrigations on all farms, with results being sent by fax or e-mail every week to the farmers. A website was created at http://www.eidnet.org/rhills/index.htm which served as a base for the project information.

Project Results: A brief summary of the first year's results can be found in Tables 1 and 2. The highest water use, 423 mm, came from Farm 3, an alfalfa crop under intensive pivot irrigation. The lowest water use, 247 mm, came from Farm 6, a canola field under wheels. Growers reported better than average yields, notwithstanding one alfalfa field under flood irrigation (Farm 2) , which suffered some winter kill and consequent yield reduction.

Conclusions: The data collected and processed in this project will be compared to both return flow data collected from the North Rolling Hills drainage channel and results from the Irrigation Requirements Model. Crop coefficients (Kc) will be analyzed, relating them to various growth stages after obtaining another year's data.

Modifications to the project in 1997 include the determination of on-farm irrigation system efficiencies. It was determined after talking with farmers that the weekly reports were somewhat of an overkill for fields other than pivots, and that biweekly information sheets were adequate. It is also expected that the web page will be improved by providing updated hourly data from the weather station. Most of the farmers taking part in the project, as well as some new ones, have shown an interest to be involved next season.

Table 1. Summary of irrigations and consumptive uses for various farms under irrigation management - 1996

All values in millimetres

Farm no.	Crop	System type	Rain	Irrigation			Crop consumptive use		
				Site 1	Site 2	Avg	Site 1	Site 2	Avg
1	Alfalfa	Wheels	72	294	187	241	382	313	347
2	Alfalfa	Flood	73	152	95	124	365	296	330
3	Alfalfa	Pivot	64	311	345	328	419	427	423
4	Barley	Wheels	89	295	299	297	260	319	289
5	Barley	Flood	68	167	200	184	291	316	303
6	Canola	Wheels	66	139	171	155	248	247	247
7	Canola	Pivot	58	272	297	285	344	370	357
8	Canola	Pivot	56	223	222	223	312	346	329
9	Oats	Flood	82	165	150	158	299	282	290
10	Wheat	Wheels	70	297	252	275	346	293	320
11	Wheat	Pivot	75	261	234	248	316	305	310
12	Wheat	Pivot	65	257	230	244	341	341	341
		Average	70	261*	249*	255*	327	321	324
		Standard deviation	9	50	53	47	48	44	41

*All flood irrigation values are for effective irrigations only and are not included in the average for 1996

Table 2. Summary values based on different crops - 1996

Crop type	Number of fields	Rainfall	Irrigation	Average crop consumptive use	Standard deviation
Alfalfa	3	73	223	339	40
Barley	2	79	231	296	7
Wheat	3	70	272	324	12
Canola	3	60	211	311	47
Oats	1	82	165	290	--

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Supporting Agencies: Farming for the Future - On-Farm Demonstration Program

Direct Seeding Barley, Peas and Canola into Pasture Sod

Objective(s): To determine if no-till seeding of barley, canola, or peas into pasture or hay land is feasible. To compare the economics of no-till seeding to conventional methods.

Background: Interest is increasing in converting pasture or hayland into a field crop using direct seeding practices. Conventional systems have high costs and require intensive tillage operations such as ploughing, heavy discing, and cultivations. These tillage operations cause the fields to become susceptible to soil erosion.

This project is a follow-up to a study conducted in 1993 and 1994. That study compared barley direct seeded into sod (1 L/acre of Roundup applied each spring) with barley seeded into a conventional, ploughed system. In the first year, grass regrowth in the no-till plots significantly reduced crop yields to about 70% of yields from the conventional plots. By the second year (1994), the no-till plots yielded higher than the conventional plots.

Division Key Results: This project will contribute to improving soil quality by using soil conservation practices. Direct seeding into sod will benefit the producer's land by protecting the soil from wind and water erosion and improving soil moisture management. A best management practice will be developed.

Project Description: This project started in 1995. Each site had three tillage treatments replicated four times in a randomized complete block design. The three tillage systems were:

1. Split fall- and spring-applied Roundup with 0.75 L/acre of Roundup and 0.24 L/acre of 2,4-D in early fall, and 0.75 L/acre of Roundup one week before seeding.
2. Spring-applied Roundup (1.5 L/acre) one week before seeding.
3. Ploughing in fall followed by three disc operations, and cultivations.

On each treatment, three species were seeded: barley (Brier), canola (Colt), and peas (Carneval). Each species was subdivided to compare a John Deere 750 series disc drill to a Harmon airdrill with hoe type openers. This project is at two sites in central Alberta: near Warburg, on a pasture field in 1995 and a hayfield in 1996; and in Edmonton at the University of Alberta Research Station on an old hay field. All plots were seeded on the same day in the first week of June.

At Edmonton, the first year sites of 1995 were studied to evaluate wheat (Roblin) growth during a second year in 1996. Direct seeding was used on the previously direct seeded main plots, and conventional tillage on the ploughed main plots.

Project Results: There was a lot of grass regrowth at both sites in 1996. The cool spring temperatures, delayed growing season, and above-average rainfall throughout the year at both sites contributed to lower grain yields than in 1995.

Barley direct seeded into sod in 1995 (with Roundup applied the previous fall) had grain yields to about 94% of yields from the conventionally ploughed plots as shown in Figure 1. The pea grain yields in the split fall- and spring-sprayed

treatments were very good. Canola yields in the split sprayed treatments were lower than the yields from the ploughed treatment. The results were similar for the John Deere drill at Edmonton and for both seeders at Warburg.

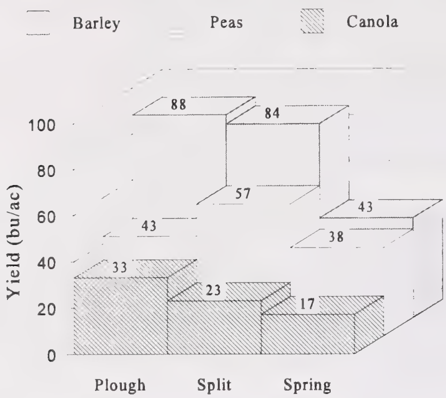

Figure 1: **Grain Yields of Harmon Airdrill in Edmonton 1995**

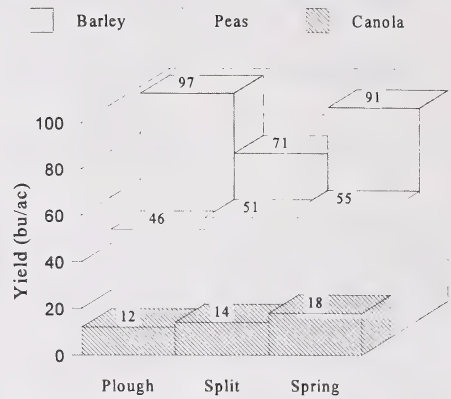

Figure 2: **Grain Yields of Harmon Airdrill in Edmonton 1996**

New sod plots were sprayed late in the fall of 1995, and the following spring it looked like a good kill. However, grasses grew back and the barley grain yields in 1996 on the split sprayed treatments were lower than expected (Figure 2). Yields above 90 bu/ac from the split sprayed treatments might have been achieved if fall spraying had been earlier and at the recommended rate. Pea yields at Edmonton in 1996 were very good but canola grain yields were not.

The first year sites of 1995 were seeded with wheat, and yields were very good (60 to 80 bu/ac). The wheat grain yields on pea stubble were significantly higher than on the barley stubble.

Conclusions: When seeding barley, fall spraying gives significantly higher grain yields than spring spraying. Using the recommended rate of a herbicide and the timing of a fall application are both important. Spring spraying can leave the barley more susceptible to numerous fungal diseases such as scald and net blotch. Direct seeding peas into pasture sod produced yields comparable to the conventionally ploughed treatment. The canola yields were not great in 1995 or 1996. This project will be repeated in 1997, and preliminary research on the nitrogen fertility aspect of seeding into sod will be initiated.

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Direct Seeding of Field Peas

Objective(s): To adapt direct seeding technology for the growing of field peas and ensure sound advice is available to producers interested in direct seeding of field peas. To evaluate how a new application method for granular Edge (surface-applied without incorporation) will fit in direct seeding systems. To compare the economics of different management practices used to grow field peas.

Background: In 1994 an initial screening test was conducted which compared four pea cultivars seeded under three different tillage systems. The 1996 research was the second year of a two-year study involving three tillage treatments, four pea cultivars and five herbicide treatments. This study was conducted on Black Chernozemic soil in Edmonton and Grey Luvisolic soil near Warburg.

Division Key Results: Direct seeding of field peas has many possible benefits for producers including: less fuel consumption, decreased labour time, conservation of soil moisture, improved soil tilth, and conservation of topsoil which is prone to erosion by wind and water.

Project Description: The field peas were inoculated and seeded into barley stubble under three different tillage systems (conventional tillage, minimum tillage, and direct seeding). The four cultivars seeded were: Montana, Highlight, Espace, and Carneval. The five herbicide treatments were: Basagran, spring-applied Edge plus Poast, Pursuit, fall-applied Edge and a control treatment with no herbicide application. The granular Edge was soil-incorporated into the minimum and conventional tillage plots; however, on the direct seeded plots the Edge was surface-applied without incorporation. All herbicides were applied at the recommended rate.

Project Results: Highlight yielded an average of 54.2 bu/ac in Edmonton which was significantly lower than Carneval and Montana which yielded 68.9 and 65.3 bu/ac, respectively. We were unable to seed the Espace cultivar in Edmonton in 1996 as the peas were too large and plugged the metering system of the Harmon airdrill.

At the Warburg site, there was only one significant difference among the four pea cultivars. The average yield for the Espace cultivar (24.7 bu/ac) was significantly lower than the average yields for Carneval (40.0 bu/ac), Highlight (38.6 bu/ac) and Montana (34.6 bu/ac).

There were significant differences among the five herbicide treatments at the Edmonton site. Yields from the three following treatments: spring Edge plus Poast (68.4 bu/ac), fall Edge (67.5 bu/ac), and Pursuit (66.8 bu/ac) were significantly higher than yields from the control (57.7 bu/ac) and Basagran (53.7 bu/ac) treatments.

There were significant differences among the herbicide treatments at Warburg.

Pea yields from either the fall-applied Edge treatments (44.0 bu/ac) or spring-applied Edge plus Poast treatments (41.3 bu/ac) yielded significantly higher than the remaining three herbicide treatments. The peas treated with Pursuit yielded 18.4 bu/ac which was significantly lower than all the other treatments, including the control. The Basagran treatments yielded 33.8 bu/ac which was not significantly different from the control treatments which yielded 34.8 bu/ac. The control and Basagran treatments yielded significantly higher than the Pursuit treatments but significantly lower than the fall Edge and spring Edge plus Poast treatments.

There were no significant differences among the pea yields for the tillage treatments at both the Edmonton and Warburg sites. The average yields for the three tillage treatments at Edmonton and Warburg are listed in Table 1.

Table 1. Average pea yields for tillage treatments

Site	Average yield (bu/ac)		
	Conventional tillage	Minimum tillage	Direct seeded
Edmonton	60.8	64.8	62.9
Warburg	34.5	31.7	37.3

Conclusions: This study showed that direct seeding of field peas is feasible. There were no significant differences among pea yields for the three tillage treatments in 1996. In 1994, when moisture levels were low, direct seeded field peas yielded significantly higher than peas seeded under conventional or minimum tillage systems. Surface-applied Edge appears to be well suited for direct seeding of field peas. There was no significant difference for the pea yields between spring-applied Edge plus Poast or fall-applied Edge at both the Edmonton and Warburg sites; however, both treatments yielded significantly higher than the Basagran and control treatments.

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Supporting Agencies: DowElanco, Monsanto Canada Inc.

Direct Seeding of Herbicide-Tolerant Canola

Objective(s): To adapt direct seeding technology for growing canola. To evaluate the use of surface-applied granular Edge. To compare two herbicide-tolerant canola cultivars to a conventional canola cultivar. To give sound advice to producers who wish to use direct seeding for canola production.

Background: Two aspects of Alberta's agriculture industry have increased greatly over the past few years: the amount of canola grown and the use of direct seeding methods. Most of the direct seeded acreage has been in cereals rather than canola. Many producers did not direct seed their canola because the herbicides suitable for growing canola usually required soil incorporation. For example, trifluralin (Treflan) and ethylfluralin (Edge) required soil incorporation as per their licensed registration. However, there have been some promising new developments in herbicides and plant biotechnology that would fit well with direct seeding of canola. These new developments are herbicide-tolerant canola varieties and the use of granular Edge as a non-incorporated herbicide.

Division Key Results: Direct seeding of herbicide-tolerant canola has many potential benefits for producers including: better weed control, less fuel consumption, decreased labour time, conservation of soil moisture, improved soil tilth, and prevention of soil erosion.

Project Description: This 1996 research project was conducted on a grey luvisolic soil located near Warburg, Alberta. Canola was seeded into barley stubble under two different tillage systems (conventional and direct seeded). Each tillage block was split by the three following Argentine canola cultivars: Quest (Roundup-tolerant), Innovator (Liberty-tolerant), and a conventional variety known as Quantum.

The tillage blocks were further split by the following six herbicide treatments: Roundup, fall-applied Edge, Poast plus Muster, spring-applied Edge plus Poast, Liberty, and a control treatment where no herbicide was applied. The fall-applied Edge was applied at 25 lb/ac and incorporated by tillage for the conventional tillage treatments and not incorporated (surface-applied without incorporation) on the direct seeded treatments.

Project Results: The canola grown in the direct seeded treatments yielded significantly higher than the canola grown in the conventional tillage treatments. Direct seeded canola yielded an average of 3.2 bu/ac higher. If that canola was sold for $9.33/bu (the selling price on October 7, 1996), then that would have been an increase of $29.85/ac. The input costs for direct seeding were $7.30/ac less than the input costs for conventional tillage. The total net return for direct seeding canola at Warburg was $37.15/ac higher than for conventional seeding.

Canola treated with spring-applied Edge plus a post-emergent application of Poast obtained the highest yields. However, these yields were not significantly higher than the yields from the herbicide-tolerant canolas treated with their

appropriate herbicides (Roundup Ready canola "Quest" treated with Roundup or the Liberty Link canola "Innovator" treated with Liberty). The third highest canola yields were achieved by canola treated with fall-applied Edge. The Poast plus Muster treatments resulted in very low yields, similar to the yields from the control treatments where no herbicide was applied. The yields and net returns for each treatment are listed in Table 1.

Table 1. 1996 Canola yields and net returns at Warburg

Herbicide treatment	Quest Yield (bu/ac)	Quest Net Return ($/ac)	Innovator Yield (bu/ac)	Innovator Net Return ($/ac)	Quantum Yield (bu/ac)	Quantum Net Return ($/ac)
Spring Edge & Poast	33.4	160.85	33.4	164.13	28.3	125.35
Roundup	28.3	148.02	Nil	Nil	Nil	Nil
Liberty	Nil	Nil	23.6	98.56	Nil	Nil
Fall Edge	21.5	70.08	18.8	48.16	22.8	94.28
Poast & Muster	11.3	-41.32	9.3	-56.61	10.5	-36.70
Control	5.9	-52.49	4.4	-63.21	6.0	-39.20

Conclusions: The results from this study show that direct seeded canola can yield significantly higher than canola grown in a conventional tillage system. Spring-applied Edge plus Poast was an excellent herbicide treatment for growing canola in a direct seeding system. The spring-applied Edge plus Poast herbicide treatment achieved the highest net return of the herbicide treatments involved in this study. Surface-applied Edge at 25 lb/ac, without incorporation by tillage, seems to work very well in a direct seeding system.

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Supporting Agencies: Dalliance

Effect of Field Shelterbelts on Crop Yields in Alberta (1990-1995)

Objective(s): To measure the effect of field shelterbelts on crop yields in order to provide information on the economics of field shelterbelts.

Background: Field shelterbelts are effective barriers to the wind thereby providing protection to the adjacent soil and crops. However, farmers are slow to implement this conservation measure because of concerns about lost crop production. Research in other parts of the world has shown that, on average, improved yields adjacent to shelterbelts compensate for lost crop production where the belt is planted as well as the zone where the shelterbelt competes with the crop. It is important to investigate this under local Alberta conditions in order to effectively promote field shelterbelts in Alberta.

Division Key Results: This project will contribute to improving soil quality by encouraging the planting of new field shelterbelts and the maintenance of existing field shelterbelts. Established field shelterbelts will reduce soil erosion and improve crop yields.

Project Description: From 1990 to 1995, 188 site years of data were collected from across Alberta. There were 182 annual cropped fields harvested that included wheat, oats, barley, peas, and canola. Six hay fields (alfalfa and grass species) were harvested. The sites were located in brown, dark brown, black, and grey soil zones. Fields were sampled to the east, west, north, and south of field shelterbelts. Shelterbelt types included: poplar, caragana, spruce, green ash, willow, native, and mixed shelterbelts.

The crops were sampled along three transects perpendicular to the shelterbelt. For the annual crops, a 1 or 2 m^2 sample was harvested by hand at distances of 0.5, 1, 2, 3, 5, 7, 10, 15, 20, and 25 times the height (H) of the belt along each transect. All distances were measured from the centre of the shelterbelt (0H). The hay fields were sampled by weighing a 5 m length of swath at different distances from the shelterbelt. Subsamples were taken to determine moisture content and calculate dry matter yield. The yield at each distance was calculated as a percentage of the assumed open field yield (average of 15H to 25H) to give relative yields for each distance. Also open field yield was compared to sheltered yield. The sheltered yield represents the weighted average yield of the area from the centre of the shelterbelt (0H) out to 15H.

Project Results: Figure 1 shows the overall yield response curve for the combined annual crop data from 1990 to 1995. On average there was a significantly lower yield in the 0H to 1.5H area (the area occupied by the shelterbelt and the competition zone) as compared to the open field at 15H. However there is a significantly higher yield in the 2H to 10H area with a maximum increase of 9% at 3H. This is a much larger area than that occupied by the shelterbelt and the zone of competition. The average relative yield in the sheltered zone (0H to 15H) was

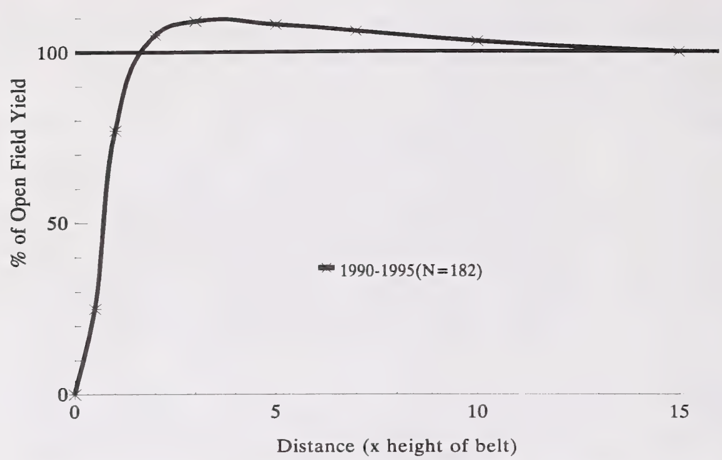

Figure 1. **The overall effect of field shelterbelts on annual crop yields in Alberta**

1% less than the open field yield. If the sheltered yield excluded the area from 0H to the crop edge then there would be about a 2% increase in yield over that in the open field. There were 69 fields that showed a gain in sheltered yield ranging from 1% to 87% and 109 fields that showed a loss ranging from 1% to 32%.

Conclusions: On average in Alberta, field shelterbelts increase yields in the 2H to 10H area which helps to compensate for the lost yield in the competition zone as well as the space occupied by the shelterbelt (0H to 1.5H). The overall net sheltered yield which includes half the area occupied by the shelterbelt is 1% less than the open field. Most of the data came from three years (1993 to 1995) with above-average precipitation. Except in a dry year, one can not expect large crop increases every year but rather an economical response over the life time of the field shelterbelt. If the concern of lost yield is not an issue then field shelterbelts should be accepted as an effective and economic soil conservation management tool in Alberta.

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Supporting Agencies: PFRA, Canada-Alberta Environmentally Sustainable Agriculture Agreement, Alberta Agricultural Research Institute On-Farm Demonstration Program

Effects of Cutting, Irrigation Management and Water Availability on the Water Use of Alfalfa

Objective(s): The objective of this project is to determine the optimum water use of alfalfa as it is affected between cutting and pre-harvest. The project findings will indicate the rate of water use increase after cutting and the number of days required to reach the pre-harvest water use levels. These findings will be used to:

1. Determine the effect cutting has on the overall water use of alfalfa under southern Alberta conditions (by 2001).
2. Determine the impact of different irrigation management practices on the yield and quality of alfalfa and on the overall consumptive use (by 2001).
3. Determine the degree of risk effects from different water deficit management strategies (by 2001).
4. Determine whether the results vary with the year of planting (by 2001).
5. Validate the cutting equation used in the Irrigation Requirements Model (IRM) (by 2001).
6. Incorporate the findings from this project into the Lethbridge Research Station Irrigation Management Model (LRSIMM) (by 2001).

Background: In September 1991, the Alberta Government announced a water management policy for the South Saskatchewan River Basin, which established guidelines for irrigation expansion. The announcement states that "these guidelines for limiting irrigation expansion will be reviewed by the year 2000". The goal of the review is to ensure that current and future water allocations can be sustained. At the same time, the irrigated agriculture industry is being challenged to increase its output to support a growing value-added industry and to become more self-reliant. This leads to trying to stretch the available water resources further. The questions facing the industry as well as the water allocation authorities are:

1. What quantity of water is and will be required for sustainable and optimum irrigated production, and
2. What will be the extent and impact of risk under deficit water supply situations.

Division Key Results: This project will contribute to improved irrigation water management and conservation. With irrigated alfalfa being the largest consumer of water, changes in the number of acres grown can have a large impact on an irrigation district's ability to meet its seasonal irrigation demand.

Project Description: A randomized complete block design will be used, with four replications. Five irrigation water treatments are to be randomly assigned within each replication. Treatments will be re-randomized at each site. Proposed site locations: Bow Island, Lethbridge, and Rolling Hills.

Figure 1 outlines the site plan for the proposed area. The block is to be irrigated with a solid set sprinkler system.

Lethbridge, Bow Island, and Rolling Hills sites will be established in 1997, with treatments first applied in 1998. To address any confounding effects of year on treatments, crop growth and water use, a second site at Lethbridge will be established in 1998 and the treatments will be first applied in 1999.

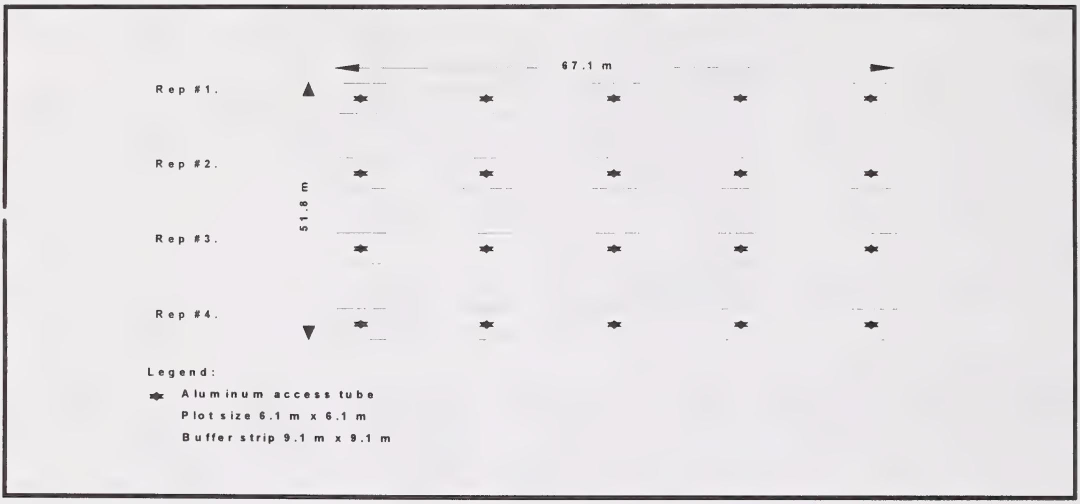

Figure 1. Site plan

Project Results: 1996 was a pilot year for this project. This pilot project was carried out to determine manpower and equipment requirements for 1997.

Conclusions: None.

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Supporting Agencies: Irrigation Branch, AAFRD

Evaluation of Moisture and Temperature Differences Between Direct and Conventional Seeding Systems in the Black Soil Zone

Objective(s): To compare seedbed soil moisture, soil temperature and crop performance differences between conventional and reduced tillage systems in the Black Soil Zone.

Background: Concerns have been raised by producers in the Black Soil Zone about cool seeding temperatures under reduced tillage systems. This project was initiated in 1995 to develop data and gain an increased understanding of soil moisture and temperature behaviour.

Division Key Results: This project will increase the understanding of soil moisture and temperature behaviour to help producers make better decisions regarding adoption of direct seeding.

Project Description: Soil temperature was continuously monitored at 2, 5, 10, and 20 cm depths. Soil moisture was determined from gravimetric methods and crop growth information was determined by square metre plant counts. Frost risk was assessed by installing exposed thermocouples at 5, 10 and 20 cm above the ground on each site in the direct seeded and the conventionally tilled fields. Overnight low temperatures were selected from the hourly data at each site and compared. As in 1995, soil temperatures within the seedrow and between the seedrow were compared. All sites were replicated at least three times.

Project Results: The direct seeded field remained warmer during the winter but warmed more slowly following spring thaw. At a given depth, the conventionally tilled field was 1 to 3°C warmer during the pre-seeding period, and was about 1°C warmer following seeding. Temperatures at the 2 cm depth in the direct seeded field were comparable to those at the 5 cm depth in the conventionally tilled field, indicating that cooler soils in the direct seeded fields can be offset by seeding shallower. The trend is similar to that observed in 1995. Within-seedrow temperatures were no different than between-row temperatures during 1996. During 1995, between-row temperatures were 0.5 to 1.0°C warmer than within-seedrow temperatures.

Soil moisture was higher in the direct seeded field during both 1995 and 1996. Plant counts were lower initially in the direct seeded field; however after three weeks the direct seeded field had a higher plant density. Wheat yields were higher in the direct seeded field during 1995 and 1996 (Figure 1).

Conclusions: Results are still considered preliminary and represent differences under cool weather. Direct seeded fields warmed more slowly in the spring, resulting in some delays in early growth. This was offset by higher moisture, higher plant populations, and higher yields. Delayed maturity may occur under direct seeding but this could not be measured due to the cold, wet fall weather. Cooler

seedbeds under direct seeded fields could be offset by seeding shallower; however there is no apparent warming advantage created in the seedrow by using a narrow opener. Crops in the direct seeded field experienced cooler overnight temperatures and a higher risk of frost. The study will continue through 1997 to further verify these findings.

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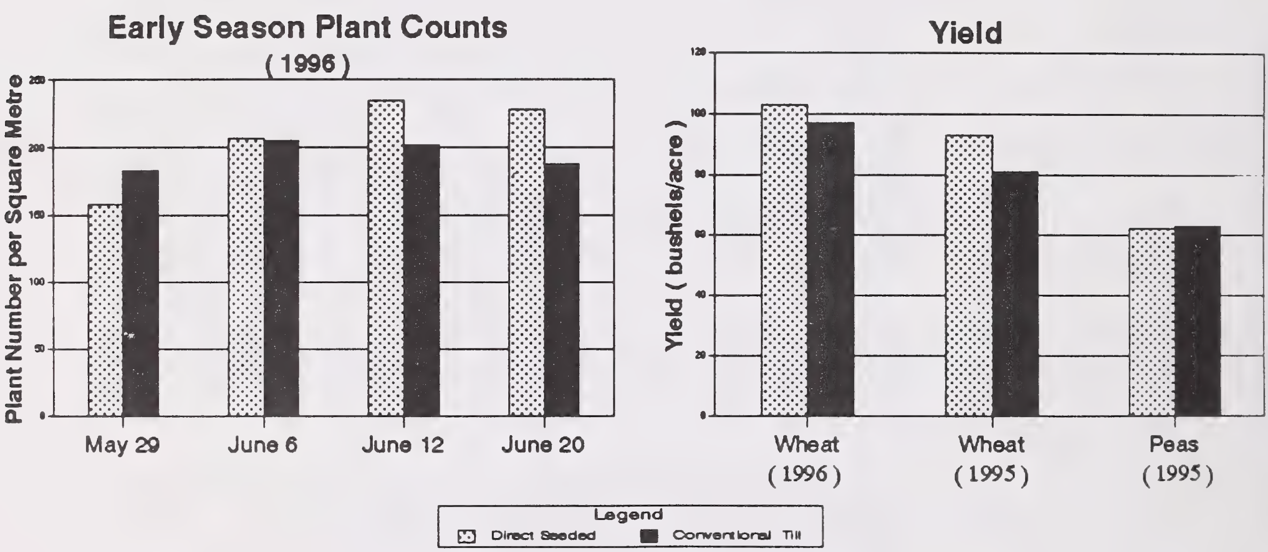

Figure 1. Plant counts following seeding on May 13, 1996, and yield data from the Ft. Saskatchewan site

Geographic Management of Agronomic and Conservation Practices

Objective(s): This project was initiated in 1994 as a two-year project to look at the application of integrated crop models on a farm field scale. The project took advantage of detailed terrain data provided by high-precision differential global positioning system (DGPS), yield mapping, and an integrated crop model called EPIC, to study the development of optimum agronomic management on a site-specific basis. The objectives of this study were to develop a computer based tool that would combine agronomic and conservation modelling within a geographic information system (GIS) to a) evaluate agronomic and conservation planning for variable field conditions, b) design farm-level agronomic and conservation strategies, and c) allow for field mapping of agronomic and conservation factors based on EPIC model predictions.

Background: Most farm fields have several soil landscape units that require individual management decisions to achieve optimum productivity and sustainability. Currently, agronomic recommendations for precision farming are based on time-consuming and costly grid soil sampling. This study investigated another option: a landscape sampling procedure where hilltops, side hills and footslopes were sampled and characterized, greatly reducing the number of sampling points required. The use of soil/crop models that can differentiate soil types within a field may prove a cost-effective means of optimizing crop production and minimizing environmental impact.

Division Key Results: Expected contributions of the project were: a) the improvement of sustainability and profitability of Alberta's agri-food industry, and b) the advancement of agricultural knowledge. The results of this project can be applied to maintain or improve soil and water quality.

Project Description: Four farmer cooperators were selected in a north-south line through Alberta in order to encompass a range of soil and climatic conditions (approximately 49 to 54° N and 112° W). One test field was selected on each farm. One site was irrigated (57 ha) and the other three were dryland fields ranging from 32 to 81 ha in size. Two sites had conventional tillage practices and two had direct seeded practices. Crops grown at the four sites over the two years included spring wheat, canola and field peas. Commercial continuous yield monitors were installed on the four different types of farm combines. The yield monitors were interfaced with portable GPS receivers when each of the project yields were harvested. Variable rate fertilization was done with a pneumatic banding applicator with two tanks for individual control of nitrogen and phosphate fertilizer. In 1994 and 1995 site-specific sampling points were characterized at all sites for the purposes of providing input for the EPIC model. Holes were dug at the shoulder, backslope and footslope positions of four hills at each site. Soil profiles were described and horizons sampled for physical and chemical analyses. Daily climate data were used from the nearest Atmospheric Environmental Service weather stations.

Project Results: This study showed that EPIC could be a good predictor of crop yields using Canadian crop parameters, local weather station data and site-specific soil data. EPIC explained 57% of the observed variation in measured crop yields when data from all sites and years were combined. Yields predicted by the EPIC model were found to be less variable than measured yields. For example, the extreme highs and lows measured in the field were not predicted. This was not surprising because EPIC does not take into consideration such factors as weed competition, lodging or salinity. The spatial variation of solonetzic properties proved difficult in both modelling and model verification. When the one site with solonetzic soils was removed from the data set, EPIC explained 72% of the variation in crop yields for the remaining sites.

The study also showed that long-term management scenarios modelled on EPIC had the potential to depict and analyse the variance in crop yields, leaching potential and erosion risk on a field basis. The GIS-model interface (GISSMO) handled various input layers for EPIC and coordinated output. Thirty year simulations were done to look at crop yield, nitrate leaching and water erosion soil loss under different tillage systems and fertilizer rates. Output could be displayed graphically across the field using a GIS.

Conclusions: The integrated crop production model EPIC can predict site-specific crop yields in Alberta with an acceptable degree of accuracy under most conditions. The model can be used to assess environmental impact of farming practices on a site-specific basis. The benefit of using an integrated model is that other features of the model can be used with little additional effort. The model could be used to test various management practices, climatic conditions, and soil conditions on crop yields and soil conservation. The potential use of an integrated model for site-specific farming could provide a very powerful tool for farmers and researchers. For example, the model could be used to develop a series of fertilizer response curves to augment field research and allow the development of curves for different soil types and climatic conditions.

This project has been completed and the final report is done.

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Supporting Agencies: Canada-Alberta Environmentally Sustainable Agriculture Agreement

Geographic Management of Fertilizer Application for Precision Farming

Objective(s): To improve the ability to distinguish among yield constraints in different soils within fields and to derive fertilizer management strategies to overcome the fertility constraints.

Background: Soils within farm fields are inherently variable in their ability to support crop production. If fertilizer is applied to fields at uniform rates, highly productive soils may be under-fertilized and less productive soils may be over-fertilized. Precision farming techniques based on global positioning systems (GPS) and variable rate technologies (VRT) may improve fertilizer efficiency and reduce environmental problems caused by excess fertilizer. These techniques allow the separation of crop yield constraints into those caused by soil fertility and those caused by other soil and climate characteristics. Such separations allow fertilizer to be used to overcome only those constraints caused by nutrient deficiency and not those caused by factors for which fertilizer is ineffective.

Division Key Results: This research will benefit producers and industry by allowing more efficient production and long-term sustainability. This project will conduct the research necessary to develop fertilizer management strategies for precision farming.

Project Description: This three-year project was started in 1996 and will make use of two sites near Olds. Fields under precision farming management will be subdivided into landscape units. Existing fertilizer recommendation algorithm software from western Canada (Alberta's AFFIRM, Saskatchewan's FARM II, and Manitoba's Fertilizer Selection Expert Systems) and mechanistic crop models (EPIC and *ecosys*) will be used to calculate predictions of yield response to fertilizer applications for each landscape unit. Predicted yield data will be compared to actual yield data collected from yield maps using combine yield monitors and GPS.

Project Results: Results showed that there is a wide range of soil nutrient levels at one Olds site based on grid sampling done by Precision Farming Solutions Inc. in the fall of 1995. In the spring of 1996, Alberta Agriculture conducted landscape sampling by setting up four transects across shoulder, backslope, and footslope landscape positions. These landscape units were sampled and characterized in detail. Soil analyses indicate results in the same range as the results of the grid soil sampling. Yield mapping of the 1996 barley yield was prepared by Precision Farming Solutions Inc. Data processing to prepare data files for model testing is underway.

Conclusions: This project is still ongoing.

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Groundwater Return Flow in the Lethbridge Northern Irrigation District

Objective(s): To characterize groundwater flow and quality in the Battersea drainage basin. To predict the effect of excess nitrate in the study area on groundwater and surface water quality over the long term.

Background: The Battersea drainage basin of the Lethbridge Northern Irrigation District, located about 15 to 20 km north of Lethbridge, has one of the highest densities of intensive livestock and poultry feeding operations in Alberta. The shallow groundwater aquifer that underlies the area provides a water supply for livestock and domestic purposes.

The potential effects of agricultural nitrate on groundwater, and on surface water through groundwater discharge, are strongly influenced by hydrogeological factors such as geology and groundwater flow. A four-year study of groundwater characteristics in the Battersea drainage basin will be completed in late 1997.

Division Key Results: Understanding the source and fate of nitrate in groundwater in the study area will allow us to develop guidelines and best management practices for the handling of fertilizer and manure in the study area. This will help to maintain and improve water quality.

Project Description: Piezometers were installed at 23 locations along a northwest- to southeast-trending transect between Blackspring Ridge and the Oldman River in 1994 and 1995. Monitoring, testing and sampling of piezometers was conducted in 1995 and 1996. Information from domestic wells is being used to supplement the information obtained from piezometers. Groundwater flow and transport modelling will be conducted in 1997 to predict the potential effect of excess nitrate on groundwater and surface water over the long term.

Project Results: An unconfined (shallow) sandy aquifer, underlain by till, covers a rectangular area of about one township, bounded on the east by the Little Bow River, on the south by the Oldman River, and pinching out in the area of Iron Springs in the northwest. Groundwater in the aquifer flows south and east to discharge into the Oldman River.

Analysis of groundwater samples obtained from 43 locations in the aquifer indicated 28 % contained no nitrate, and 42 % contained nitrate at levels below the drinking water guideline for humans (10 mg/L). Twenty-three percent of locations contained 10 to 53 mg/L, and 7% contained 80 to 120 mg/L NO_3-N. The drinking water guideline for cattle is 100 mg/L NO_3-N. Groundwater with nitrate tended to occur near nitrate sources such as feedlots, fertilized or manured fields, or manure storage areas. Aquifer groundwater with high nitrate often contained fecal coliform, at maximum levels of over 23 counts per 100 ml.

With the exception of nitrate, groundwater quality in the aquifer tends to be

good, with major-ion concentrations generally falling below the drinking water guidelines. Locations with the highest nitrate contained elevated levels of all major ions, causing drinking water guidelines to be exceeded for all major ions. Metal analysis at one contaminated location suggested boron, zinc, copper and lead may also be elevated in highly contaminated locations.

Downward leaching of nitrate through the aquifer with time has been recorded at a limited number of locations. Leaching and transport rates will vary with groundwater conditions at each location. Analysis of N_2/Ar ratios indicated denitrification was occurring in reduced sediments at two locations. Reduced sediments occur only near the bottom of the shallow aquifer at some locations. Elsewhere the aquifer is oxidized, and geochemical analyses suggest denitrification is not occurring to any appreciable extent.

In contrast to groundwater in the aquifer, groundwater in till in the Battersea drainage basin contains very high levels of dissolved solids and sometimes contains very high levels of nitrate (up to 40 times the drinking water guideline). The high dissolved solids and nitrate in till are derived from natural processes. The poor quality and low volume of groundwater in till render it naturally unsuitable for use as an aquifer.

Conclusions: The shallow aquifer in the Lethbridge Northern Irrigation District is susceptible to contamination with nitrate, inorganic salts and trace metals. Evidence suggests denitrification occurs only in reduced sediments at the bottom of the aquifer in some locations. Groundwater in locations where the aquifer is absent is much less susceptible to contamination, due to the naturally poor quality and limited volume of groundwater in till.

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Groundwater Return Flow in the Western Irrigation District

Objective(s): To characterize groundwater flow and quality in the Western Irrigation District (WID), located east of Calgary. To determine the effect of irrigation groundwater flow and quality, and surface water and soil quality, in the study area.

Background: Irrigation has been conducted in the WID since 1905. An increase in the number of irrigated hectares and the upgrading of existing water distribution systems have been proposed for the district. Groundwater in the WID is used extensively for agricultural and domestic purposes. Groundwater discharge may affect the quality of soils and surface water. The effect of irrigation on groundwater, surface water and soils is strongly influenced by hydrogeologic factors such as topography, geology, groundwater flow and groundwater quality. The current study was conducted to determine these influences. The project was completed in 1997.

Division Key Results: This project identified factors that influence the quality of groundwater, surface water and soils in the WID. The information can be used to identify best management practices that will help maintain or improve the quality of the groundwater aquifer, soils and surface water in the district.

Project Description: Piezometer nests were installed at 25 locations along three transects through the central portion of the WID in 1989 to 1991. Groundwater flow and quality were characterized. The investigation included the collection and analysis of field data from the piezometers, and compilation and analysis of existing information from almost 1000 domestic wells in the study area. Computer simulation of groundwater flow using VISUAL MODFLOW provided more information on groundwater discharge and the effects of irrigation.

Project Results: Groundwater for domestic and agricultural consumption is produced mainly from sandstone layers with high hydraulic conductivities, but limited extent, at depths up to 150 m. Groundwater chemistry evolves from sodium-sulphate at shallow depths, to sodium-bicarbonate-chloride at greater depths. Groundwater quality is good, with the exception of sodium, which exceeded the Canadian drinking water guidelines in almost all samples. Drinking water guidelines for manganese were often exceeded in shallow groundwater, while arsenic occasionally exceeded guidelines in deep groundwater. Sodium, manganese and arsenic all occur naturally in the groundwater.

Low levels of agriculturally derived nitrate were detected in shallow groundwater at several locations. Nitrate was detected at greater than 2 mg/L in about 20% of domestic wells, and drinking water guidelines were exceeded in 8% of wells. Most of the detections in domestic wells are probably of point-source origin. The presence of nitrate in shallow groundwater and the aquifer suggests denitrification will not remove nitrate once it enters groundwater.

Groundwater flows from a bedrock high near the centre of the study area, north to discharge into Serviceberry Creek, northeast to the Bow River via Crowfoot Creek, and southwest to the Bow River via Eagle, Namaka and Stobart Lakes. Estimates of groundwater recharge using three methods (water-balance, tritium and computer simulations of groundwater flow) ranged from 30 to 34 mm/yr. Field data and water-balance estimates suggest canal seepage could account for up to approximately 18% of annual recharge in the study area, while irrigation causes about 6% of annual recharge.

Groundwater discharge and soil salinization in the study area are promoted by shallow bedrock, rolling topography, and the high ratio of horizontal (3 to 4 mm/yr) to vertical (6 to 750 mm/yr) groundwater flow. Simulations using VISUAL MODFLOW suggested groundwater discharge to Eagle, Namaka and Stobart Lakes and Crowfoot Creek was about 6.4×10^5, 3.2×10^5, 1.2×10^5 and 1.9×10^6 m^3/yr, respectively. This amount of groundwater discharge was estimated to increase dissolved salt levels by 37, 19, 15 and 161 mg/L/yr, respectively, for the four surface water bodies.

Conclusions: The bedrock aquifer in the study area is of relatively high quality and has a high hydraulic conductivity. It is, therefore, a most valuable resource. The detection of low levels of agriculturally derived nitrate in shallow groundwater at several locations indicates the groundwater is susceptible to nitrate contamination. Canal seepage results in a significant increase in recharge to groundwater at some locations. Increased recharge will increase the potential for groundwater contamination, and for salinization of surface water and soils through groundwater discharge. It is recommended that nitrate leaching and canal seepage be minimized to maintain or improve the quality of the groundwater, surface water and soils in the study area.

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Irrigation Block Study

Objective(s): To calibrate the Irrigation Requirements District Model using field data from two irrigation blocks, Bow River Irrigation District (BRID) and Lethbridge Northern Irrigation District (LNID). From the information collected, to evaluate the irrigation districts' present water allocation criteria. To develop and test new management strategies to manage inflow, reduce return flows and improve on-farm use.

Background: In May 1990, Alberta announced a water management policy for the South Saskatchewan River basin that established guidelines for irrigation expansion. The announcement stated that "these guidelines for limiting irrigation expansion will be reviewed in the year 2000". In order to make proper water management decisions, accurate and complete information regarding water supply, crop use and return flow databases for the irrigation districts is required. The current review process of the Water Resources Act has highlighted many policy issues with potential implications for water management within the irrigation districts. This new water management policy reflects the increasing pressure on the resource.

Division Key Results: This project will contribute to the improvement of irrigation water management and conservation. With irrigation being the largest water user in the South Saskatchewan River Basin, it is extremely important that water diverted for irrigation is conveyed, stored and used wisely by all.

Project Description: The block selected in BRID, known as K-5, is located 15 km northwest of the Town of Vauxhall and was completely rehabilitated in 1991. All water entering and leaving the block is measured using electronic data loggers complete with water level equipment. Cutthroat flumes constructed of pressure treated plywood were installed in the spring of 1994. These flumes were installed in most farm head ditches used for gravity irrigation. Electronic data loggers completed with water level equipment were installed prior to irrigation. Propeller type flow meters have been installed on 10 sprinkler systems.

The block selected in LNID, known as J-12, is located near the Town of Iron Springs. The lateral was rehabilitated in 1985. This block is entirely sprinkler irrigated. Propeller type flow meters have been installed.

Automated weather stations have been set up at both locations to collect temperature, solar radiation, rainfall, relative humidity and wind travel data.

Project Results: In both areas, spring soil moisture conditions were excellent. Precipitation for April was near normal for the Enchant area (81%) but was only 51% for the Iron Springs area. Precipitation for the months of May, June, and July averaged 65% for the Iron Springs area and 63% for the Enchant area. Mean daytime temperatures for these same three months were slightly above normal.

Table 1 summarizes the flow data for each block for the last three years. As a percentage of inflow, BRID return flow ranges from 39.3% to 41.4% whereas LNID return flow ranges from 14.6% to 26.9%.

Table 1. Summaries of flow data for each irrigation block, 1994 to 1996

Year	Inflow (decametre^3)				Return flow (decametre^3)			
	Crop growing season		Fall irrigation		Crop growing season		Fall irrigation	
	BRID	LNID	BRID	LNID	BRID	LNID	BRID	LNID
1996	4561	4336	396	481	1790	736	243	175
1995	4612	3223	394	761	1910	868	297	359
1994	5677	5734	1283	1920	2307	835	711	586

Conclusions: Regardless of the amount of precipitation that falls during the crop growing season, the BRID has a return flow that remains fairly constant. A reason for this consistent return flow may be the large percentage of surface irrigation in the area. In contrast, in the LNID, the majority of the irrigation systems are sprinkler, which allows the district to control the water better.

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Supporting Agencies: Alberta Environmental Protection, Bow River Irrigation District, Lethbridge Northern Irrigation District, Irrigation Branch, AAFRD

Irrigation Requirements Model (IRM) Calibration and Application

Objective(s): To assess and further develop the existing IRM and apply it to determine: existing distribution and on-farm water management for the irrigation districts, and project potential water demands and efficiencies for the Year 2000 review.

Background: Since the mid 1980s, Alberta Environmental Protection had been developing a model which it could use to predict block water demands for various years within an irrigation district. This information in conjunction with the Water Resources Management Model would then be used in determining whether sufficient water in a river basin would yield sufficient water to meet the needs of an irrigation district. This information would then be used to set water licence values for each irrigation district.

Division Key Results: This project will contribute to improved irrigation water delivery and application efficiencies. Once the enhancements are completed, both government and irrigation district staff will be able to use this model for developing better water management plans and strategies.

Project Description: This model is used to calculated a gross water demand for an irrigation block. The gross water demand is made up of gross irrigation demand (on-farm) + canal evaporation + canal seepage + base flow. The original format of this model was developed in Fortran. Due to the difficulty of entering and editing data, a consultant was hired to modify the data entry and editing process. The model is currently being tested and calibrated using data obtained from our Irrigation Block project (see Irrigation Block Study, page 29).

Project Results: With phase one of the project completed, addition of the interface, preliminary results show that the model does a reasonably good job of tracking gross irrigation block water demands. Table 1 compares the model to actual amount of water diverted into the block. Over the irrigation season, the model underestimated demand flow by 17.3% and return flow by 24.6%.

Table 1. Comparison of modelled flow data with measured flow for K-5 block

	Total inflow (decametre^3)	Total return flow (decametre^3)
IRM modelled flow	6233	2339
Measured flow	7537	3102

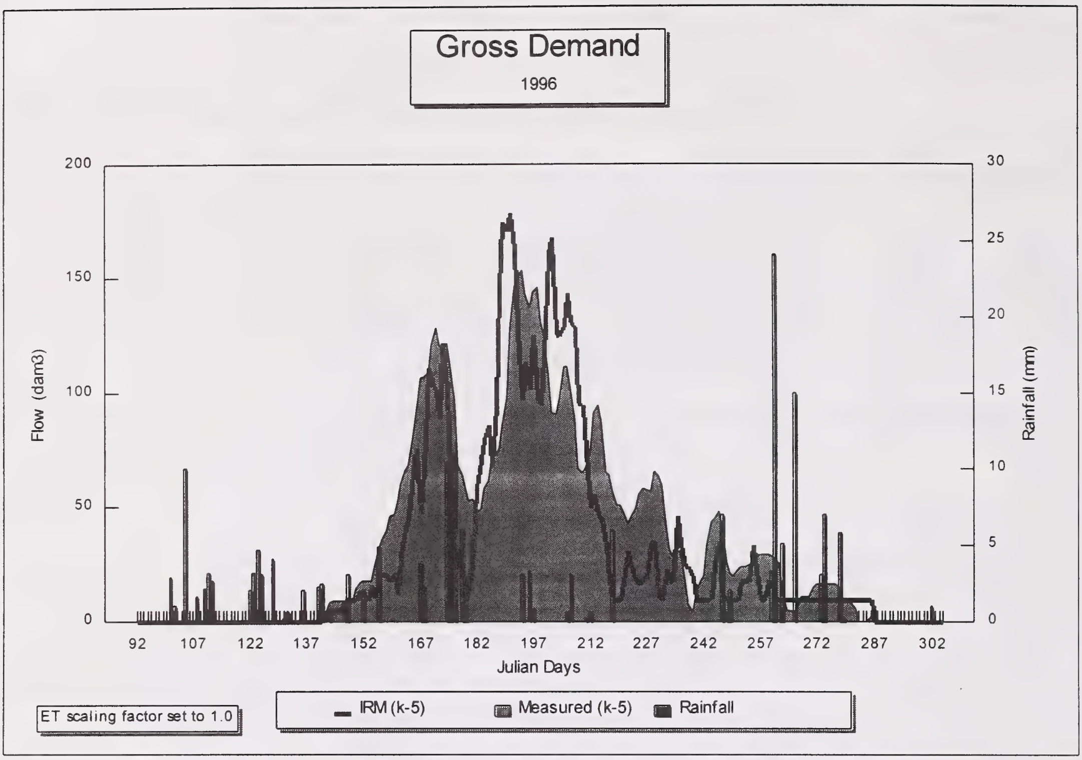

Figure 1. Gross diversion for K-5 block

Figure 1 outlines the performance of the model compared to the measured results obtained in the field.

Conclusions: Calibration of the Irrigation Requirements Model will continue. Minor adjustments are required on the demand side of the model. Logic for rainfall runoff and return flow needs to be strengthened in this model.

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Site-Specific Management of Potatoes

Objective(s): To measure the variability of yield in potato fields and determine what soils or environmental factors in that crop or the preceding crop have influenced the yield. To develop improved recommendations that will optimize the applications of inputs and minimize the risks of environmental contamination.

Background: Traditionally, entire fields of many crops, including potatoes, have been managed as one unit and variability of soils within the field have not been taken into account. Large scale farming has made this problem more severe. The development of global positioning technology, yield monitoring and other computer technology such as geographic information systems have made site-specific management of fields possible. Potatoes are a high value crop which require large amounts of inputs. Excess inputs may cause environmental impacts such as groundwater contamination and insufficient inputs may reduce yield.

Division Key Results: To determine the costs, benefits and environmental influence of site-specific management of potatoes. To evaluate the uses of remote sensing and digital imagery analysis to detect nutrient deficiencies and diseases of potatoes.

Project Description: Two potato fields will be yield mapped each year for four years starting in 1996. Detailed information on soil texture, topography, rainfall, irrigation, soil moisture and tissue analysis of petiole samples will be collected at about 50 sites on each field. In 1997, fertilizer treatments will be applied on a portion of each field. Tuber samples will be collected and quality analysis will be done on tuber samples. The use of remote sensing and digital imagery analysis to identify nitrogen deficiencies and stresses will be evaluated.

Project Results: In 1996, two 27 ha potato fields were monitored in detail. Soil texture was determined at 48 points and at these points rainfall, irrigation and soil moisture records were kept weekly and plant petiole samples for nutrient analysis were taken three times. Yield data and remote sensing imagery were also collected.

The project has shown that soil texture, tissue nutrient and available soil moisture status of potato fields are variable. Tissue phosphorus as well as nitrogen was found to decline rapidly during the growing season in portions of the potato fields. Soil moisture was found to be lower under the outer portions of the centre pivot. Difficulties were encountered with the prototype potato yield monitor. A late and wet fall meant the farmers were harvesting under wet conditions and considerable soil was often included. Preliminary potato yield maps were prepared in 1996.

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Soil Erodibility Studies

Objective(s): To measure WEPP baseline soil erodibility parameters for a wide range of Alberta soil types. To characterize and rank the erodibility of Alberta soils.

Background: WEPP is a computer simulation model capable of predicting water erosion for any farm management scenario. In addition to soil losses, WEPP will predict deposition and sediment delivery to receiving water bodies.

During an erosion event, soil particles are detached and transported by two major processes known as interrill erosion and rill erosion. Interrill erosion results from raindrop impacts and shallow sheet flows. Rill erosion results when runoff generated from the interrill areas concentrates into small rivulets called rills. Within rills, soil is detached and transported via scour, head cutting and sidewall slumping. WEPP recognizes both processes and assigns each soil type a unique set of erodibility parameters that characterizes the soil's susceptibility to rill and interrill erosion. The output generated by WEPP is extremely sensitive to input values for soil erodibility. Equations used to predict WEPP soil erodibility parameters were developed on soils found throughout the United States. In Alberta, soils are generally younger, resulting in differences in clay mineralogy and higher organic matter levels. These differences may render the WEPP erodibility equations inadequate for use with Alberta soil types. Therefore, characterizing WEPP soil erodibility parameters for Alberta soil types is very important.

Division Key Results: WEPP can be used to select best management practices aimed at reducing soil losses thereby improving soil and water quality.

Project Description: To date, 13 sites have been tested. These soils represent a broad range of textures and organic matter contents including soils of the Chernozemic, Luvisolic and Solonetzic orders.

A soil's susceptibility to rill erosion is characterized by K_r, the rill erodibility of soil due to hydraulic shear, and τ_c, the critical hydraulic shear below which no soil detachment occurs. To derive these factors for a given soil, rill erodibility tests are conducted by constructing four small channels on a freshly cultivated soil surface. Each rill is then subjected to flow rates of 12, 19, 26, 33, 40 L/min. For each flow rate a series of sediment samples and rill cross-section measurements are taken. These data are used to derive values for K_r and τ_c.

The interrill erodibility of a soil is characterized by the K_i factor. Interrill erodibility tests are conducted in the lab using simulated rainfall. From each rill erodiblity test site, 100 kg of soil is collected and taken back to the lab. This soil is then subject to a simulated rainstorm of 60 mm/h. Data collected from this test allow values for K_i to be calculated.

Project Results: The following table summarizes the calculated values for K_r, τ_c and K_i for the soils tested so far. Note that the interrill erodibility parameter is closely related to soil texture. The rill erodibility parameters are not. This suggests that other

Table 1. Summary of calculated soil erodibility values for 13 Alberta soil types

Location	Texture	K_i ($\times 10^{-6}$) kg/s	K_r ($\times 10^{3}$) s/m	τ_c Pa
Stony Plain	loam	21.92	1.48	0.60
Wetaskiwin	sandy loam	16.07	2.19	1.03
Lomond	loam	9.79	5.54	3.50
Tofield	loam	8.22	2.36	0.53
Breton	loam	7.53	2.12	0.53
Tofield	loam	7.16	1.61	0.78
Lacombe	silt loam	6.31	1.35	2.27
St. Albert	silty clay loam	5.96	2.57	2.83
Edmonton	silty clay loam	5.67	1.61	-0.70
Clive	clay loam	4.69	1.95	2.10
Lomond	clay loam	4.49	1.84	2.94
Three Hills	heavy clay	3.44	4.79	2.82
Sexsmith	clay	2.80	3.44	1.89

factors are influencing the rill erodibility of a soil (for example, organic matter content, aggregate stability, clay mineralogy, etc.). Further work will determine what specific soil properties are related to WEPP soil erodibility parameters.

Conclusions: By the end of the 1997 field season a total of 25 soils will have been tested. This information will be used to determine which soil properties are related to the various soil erodibility parameters. WEPP prediction equations will be evaluated. If they are accurate, they will be used to predict soil erodibility values for most Alberta soil types. However if they fail, then new equations will be developed which will allow accurate estimates of soil erodibility parameters for Alberta soils.

The soils information contained within the CanSIS database will be used to calculate soil erodibility values for most of the soils found within Alberta. Soil erodibility information can be used to improve soil erodibility risk maps, add to existing soils databases and improve the reliability of water erosion predictions.

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Sustainable Cropping Systems Research Study

Objective(s): To compare the effect of conventional tillage versus low disturbance direct seeding on nine different crop rotations. To see if certain crop rotations are better suited for direct seeding than others. To study the effect of potassium chloride (KCl) on crop yield.

Background: Until recently the emphasis of research into direct seeding has been equipment oriented. Most research that compares direct seeding to conventional and minimum tillage systems involves only one crop variety or crop rotation. This research study compares nine different crop rotations under direct seeding and conventional tillage, and evaluates the effect of chloride on crop yield.

Division Key Results: This research is intended to complement other study sites that are part of the Alberta Agricultural Research Institute Sustainable Cropping Systems Research Study Group. Producers will be able to use information generated from the study to decide which management system is best for their operation.

Project Description: The study consists of 20 main plots, randomly assigned among three replicates, at a site near Three Hills in south central Alberta. Descriptions of the nine crop rotations are listed in the Project Results section. Each plot is split into two tillage treatments, conventional tillage and direct seeding, and further split into two fertility treatments, KCl or no KCl. Macronutrient levels are applied according to soil test results.

Project Results: In 1996, rainfall at the Three Hills site was above average during May and September and below average during June, July and August. The monthly rainfall rates and 30-year averages are listed in Table 1.

Table 1. 1996 and 30-year average rainfall

Rainfall (mm)	May	June	July	Aug.	Sept.
1961-1990 average	43.1	68.3	70.2	48.4	44.8
1996	57.9	47.5	42.2	15.8	63.3

Two of the nine rotations are continuous forage treatments. In 1996 there were no significant differences in forage production between these two treatments. The alfalfa and brome treatments yielded an average of 2281.5 kg/ha dry matter, and the continuous brome grass treatments averaged 2148.1 kg/ha.

Seven of the nine rotations involve at least one year of wheat, and one rotation has wheat seeded two out of three years (wheat-wheat-fallow). Each stage of every rotation is seeded annually; therefore, a comparison of yield among the following eight wheat treatments serves as a comparison among the seven rotations:

#1-Continuous wheat
#2-Canola-barley-peas-wheat
#3-Wheat-fallow
#4-Wheat-green manure (peas)
#5-Wheat-wheat-fallow
#6-Wheat-wheat-fallow
#7-Peas-wheat-fallow
#8 - Wheat-silage-fall rye

The 1996 wheat yields are listed in Table 2.

Table 2. 1996 Wheat Yields (bu/ac)

Rot. #1	Rot. #2	Rot. #3	Rot. #4	Rot. #5	Rot. #6	Rot. #7	Rot. #8
37.0 (c)	40.4 (bc)	51.7 (a)	44.4 (ab)	48.9 (a)	40.5 (bc)	47.2 (ab)	28.4 (d)

Values followed by the same letter are not significantly different at P=0.05.

The highest wheat yields in 1996 were achieved by wheat grown after fallow. There was no significant difference among wheat yields in rotations #3, #5, #7, and #4. The wheat grown after fallow in rotations #3 and #5 yielded significantly higher than wheat grown in rotations #6, #2, #1, and #8. Wheat yields from rotation #8, a low input rotation, were significantly lower than the remaining seven wheat treatments.

There was no significant difference observed among the wheat yields in rotations #7, #4, #6 and #2. However these four rotations had wheat yields which were significantly higher than wheat grown in rotations #1 and #8 and significantly lower than wheat grown after fallow (rotations #3 and #5).

There were no significant differences in yield observed between the two tillage treatments, nor between the two soil fertility treatments in 1996.

Conclusions: Growing conditions were unusually dry at Three Hills during June, July and August of 1996. As a result, the best wheat yields were achieved by rotations which had a fallow treatment during the previous year. The 1996 results are very different from the results found in years when rainfall levels were average. In 1995, rainfall levels were average and the best wheat yields were obtained from the canola-barley-peas-wheat rotation.

Forage production was very low at Three Hills in 1996 due to the low amounts of rainfall and only one cut could be harvested.

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Supporting Agencies: Agrium

Water Erosion Monitoring Study, WEPP Validation

Objective(s): To build a database for evaluation of water erosion prediction models under Alberta soil and climate conditions.

Background: The USDA Water Erosion Prediction Project (WEPP) model can evaluate the impacts of conservation tillage, crop rotations, crop residue management, and the use of tillage implements on soil loss on agricultural land.

Division Key Results: Adaptation and use of the model will help to develop management practices that reduce water erosion under Alberta conditions.

Project Description: Four monitoring sites are in full operation near the following towns: Tofield, Breton, Lacombe, and Sexsmith. Detailed descriptions regarding data acquisition and site instrumentation are included in the "CAESA Soil Quality Water Erosion Research Annual Report 1994/95" (Jedrych et al. 1995). This report includes only the results from the Tofield site. Results from the Breton, Lacombe and Sexsmith sites will be available in the 1996/97 CAESA report.

Project Results: Long term average precipitation for the Tofield research station is 320.6 mm for the May-September period, and 473.4 mm for the year. 1995 was a dry year at the site (Table 1). Precipitation was 37% below the long term average for the area. During the first year at the site, four runoff events were monitored. The spring and summer runoff events generated 951 kg/ha and 550 kg/ha of soil loss at the east watershed, with runoff coefficients of 0.77 and 0.33, respectively. The west watershed was instrumented at the beginning of summer and recorded only 134 kg/ha of soil loss. The east and west watersheds are 0.48 and 0.51 ha in size, respectively.

Table 1. Summary of watershed hydrology data from Tofield site, 1995

Runoff events	Precipitation	Runoff volume (mm)		Soil loss (kg)	
	Amount (mm)	East watershed	West watershed	East watershed	West watershed
March 20-26 Mar. 27-Apr. 01	62.2 mm of water equivalent	21.9 26.0	na* na	144.7 315.0	na na
Total spring snowmelt		47.9	na	459.7	na
August 07-10 August 11-14	47.5 10.4	12.5 6.6	1.7 2.2	167.6 98.2	27.6 39.0
May-September	202.74	19.1	3.9	265.9	66.6
Annual soil loss (kg/ha)		67.0	na	1502	na
Spring runoff coefficient		0.77	na		
Summer runoff coefficient		0.33	na		

* na = not available

The runoff volume and soil loss from the Tofield watersheds for 1996 are included in Table 2. The low spring soil loss was attributed to a high surface residue cover, gradual snowmelt, and no fall cultivation.

Table 2. Summary of watershed hydrology data from Tofield research site, 1996

Runoff events	Precipitation		Runoff volume (mm)		Soil loss (kg)	
	Amount (mm)	Duration (h)	East watershed	West watershed	East watershed	West watershed
March 14-18	61.4 mm of water equivalent		27.09	36.07	131.8	90.7
April 4-8			20.11	21.82	200.7	86.3
Total spring snowmelt			47.2	57.9	332.4	177.0
June 4-5	18.3	10.75	0.50	0.17	30.9	21.5
June 18-24	36.9	36.83	8.01	1.80	106.5	23.7
July 4	10.2	10.16	2.38	3.06	213.7	265.0
July 10	17.0	11.32	3.92	1.72	95.4	36.8
July 18 -19	32.5	3.65	21.72	24.74	2501.0	2823.0
August 3-6	49.0	42.70	23.10	8.19	1950.7	457.0
Sept. 16-20	45.4	45.97	18.65	3.20	87.5	10.0
Sept. 27-29	13.5	13.47	5.65	4.51	20.2	15.6
May-September	329.4		83.92	47.39	5005.9	3652.5
Annual soil loss (kg/ha)					11039.1	7510.3

Summer precipitation in 1996 was only 2.7% above the long term average for the area. Most storms had intensity ranging between 1 and 2 year return periods. Annual soil loss ranged between 11039 kg/ha and 7510 kg/ha on the two watersheds. However, the July 18 storm had a 10 year return period and accounted for nearly 50% of the annual soil loss. This high soil loss was attributed to the fact that the research site is situated on Solonetzic soils. These soils have a hardpan layer 0.15 m below the soil surface. This prevents water entering deeper into the soil profile and contributes to a high runoff and water erosion potential.

Conclusions: In spite of normal precipitation during the 1996 growing season, the barley field experienced a major soil loss. Both watersheds exceeded the annual tolerable soil loss of 1500 kg/ha/year (Tajek et al. 1985) by several times.

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Yield, Rooting Depth and Soil Water Use of Alfalfa in the Black Soil Zone of Alberta

Objective(s): To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control

Background: Alfalfa can control rainfed salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results: This project will contribute to improving soil quality by encouraging alfalfa production which will benefit the land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description: The Black soil zone site is located on the Parkland Conservation Farm (N½ 9-53-16-W4) approximately 80 km east of Edmonton. Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. One fallow plot was established in each replication to serve as a control. Each of the plots were 2 m by 6 m in size. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique. Readings were taken at 25 cm, 50 cm and every 50 cm thereafter to a depth of 550 cm. Each plot was harvested twice in 1995 and in 1996, and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates and for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results: Figure 1 presents the two-year mean yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. Apica yielded the highest, with a total, two cut per year, dry matter weight of 7,543 kg/ha. Algonquin extracted the most soil moisture at 380 mm. Heinrichs alfalfa rooted deepest to a depth of 185 cm.

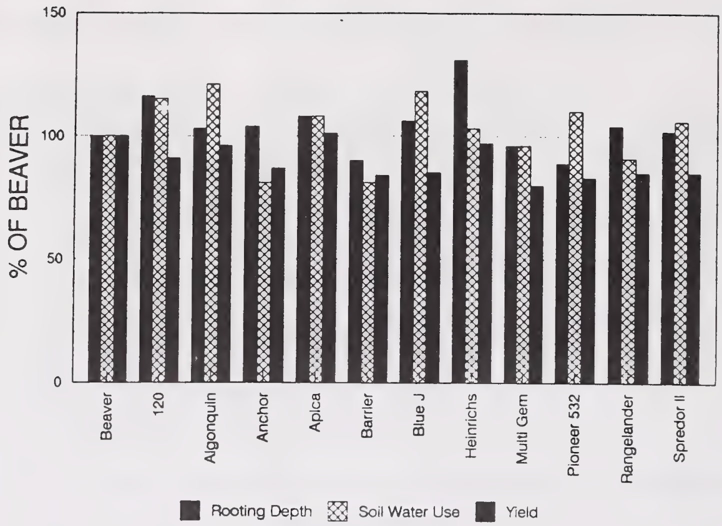

Figure 1. Two-year mean yield, rooting depth and soil water use for 12 alfalfa varieties in the Black soil zone

Conclusions: After two complete growing seasons (1995 and 1996), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Black soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt-affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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Yield, Rooting Depth and Soil Water Use of Alfalfa in the Brown Soil Zone of Alberta

Objective(s): To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control

Background: Alfalfa can control rainfed salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results: This project will contribute to improving soil quality by encouraging alfalfa production which will benefit the land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description: The Brown soil zone site is located adjacent to the Chinook Applied Research Association facility (NE34-27-4-W4) in the town of Oyen. Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. Plot sizes are 2 m by 6 m and a fallow plot was established in each replication to serve as a control. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique at 25 cm, 50 cm and every 50 cm thereafter to a depth of 550 cm. Each plot was harvested twice in 1995 and in 1996, and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates and for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results: Figure 1 presents the two-year mean yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. Beaver yielded the highest, with a total, two cut per year, dry matter weight of 11,555 kg/ha. Algonquin extracted the most soil moisture at 548 mm. Beaver alfalfa rooted deepest to a depth of 292 cm.

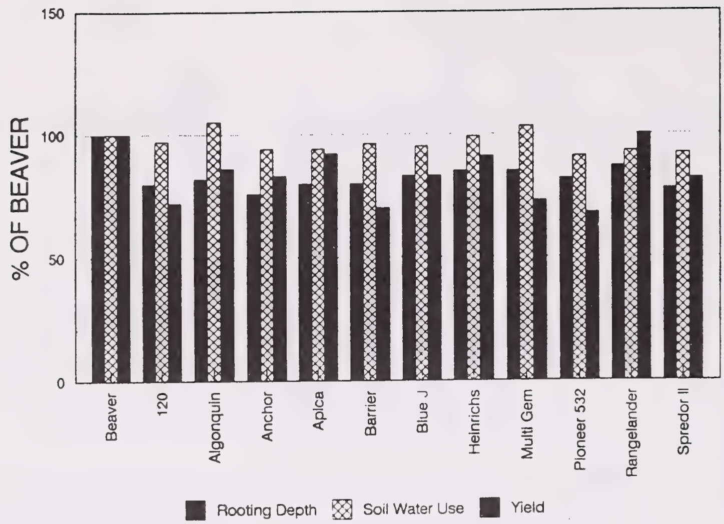

Figure 1. Two-year mean yield, rooting depth and soil water use for 12 alfalfa varieties in the Brown soil zone

Conclusions: After two complete growing seasons (1995 and 1996), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Brown soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt-affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much-needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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Supporting Agencies: Canada-Alberta Environmentally Sustainable Agriculture Agreement

Yield, Rooting Depth and Soil Water Use of Alfalfa in the Dark Brown Soil Zone of Alberta

Objective(s): To evaluate 12 alfalfa cultivars to develop reliable recommendations on yield, rooting depth and soil water use for soil salinity control

Background: Alfalfa can control rainfed salinity by reducing local groundwater flow to saline seeps. However, different alfalfa cultivars differ markedly in rooting depth, soil water extraction and yield. As well, each cultivar performs differently in different soil zones. To improve adoption of alfalfa for salinity control, producers need to know which alfalfa cultivars give the best salinity control along with the highest yields. Current recommendations on alfalfa cultivars for salinity control are based on research done in Montana before 1980, when many of today's improved varieties were not available.

Division Key Results: This project will contribute to improving soil quality by encouraging alfalfa production which will benefit the land and the surrounding landscape by controlling salinity, reducing soil erosion and adding soil nitrogen and organic matter.

Project Description: The Dark Brown soil zone site is located at the Lethbridge Agriculture Centre (S½ 3-9-21-W4). Plots were seeded in 1994 with 12 varieties of alfalfa, randomized and replicated four times. One fallow plot was established in each replication to serve as a control. Each of the plots were 2 m by 6 m in size. Each plot was instrumented with a centrally located, 6 m long by 5 cm diameter aluminum access tube to allow reading of soil moisture at depth. Soil moisture was read monthly throughout the growing season using the neutron scatter technique. Readings were taken at 25 cm, 50 cm and every 50 cm thereafter to a depth of 550 cm. Each plot was harvested twice in 1995 and in 1996, and dry matter yields were determined. Rooting depth and soil water use analyses are based on the mean value from four plots, from six sampling dates and for each cultivar. Graphs of soil moisture at depth for each variety were plotted along with the fallow treatment. The intersection of the fallow and moisture use lines indicates rooting depth. The area from the 25 cm depth to the intersection point was planimetered to determine soil water use.

Project Results: Figure 1 presents the two-year mean yield, rooting depth and soil water use for each of the 12 alfalfa varieties evaluated. Performance is presented as a percentage of Beaver. Blue J yielded the highest, with a total, two cut per year, dry matter weight of 11,160 kg/ha. Rangelander extracted the most soil moisture at 573 mm. 120 alfalfa rooted deepest to a depth of 356 cm.

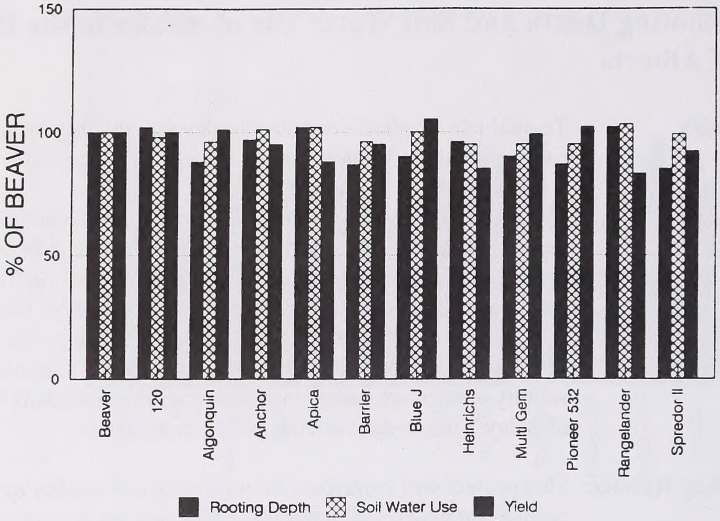

Figure 1. Two-year mean yield, rooting depth and soil water use for 12 alfalfa varieties in the Dark Brown soil zone

Conclusions: After two complete growing seasons (1995 and 1996), preliminary data are available on the yield, rooting depth and soil water use of 12 varieties of alfalfa in Alberta's Dark Brown soil zone. This data set will become more complete in subsequent years as the individual performance of each variety becomes more distinct.

The selection of the most suitable alfalfa cultivar will provide optimum control of shallow groundwater and hence, the most rapid control and reclamation of salt-affected land. As well, it will be possible to realize the highest possible economic net return from the land. Determination of yield, rooting depth and moisture use for 12 alfalfa cultivars on the basis of soil zone will provide much-needed, statistically verifiable information. Such data may give insight into selection criteria for development of new alfalfa cultivars for this specific purpose.

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